An Easy Non-GIS Method for Making 3-D Digital Terrain Illustrations Using USGS 1:24,000- and 1:250,000-Scale Digital Elevation Models and Bryce4 Software

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ABSTRACT

Three-dimensional (3-D) digital terrain illustrations offer the graphic designer and scientist an excellent way to portray certain geologic, geomorphic, tectonic, and topographic features for a range of scientific and popular publications. Making such illustrations has, until recent years, required the use of sophisticated GIS software, a steep learning curve, and much time and patience. A non-GIS software, Bryce4, used in conjunction with Adobe PhotoShop and Illustrator, provides graphic designers and scientists with an easy way to use USGS 1:24,000- and 1:250,000-scale Digital Elevation Models (DEM's) to make attractive 3-D terrain illustrations for use on the Web and in print and electronic publications. On this poster, we present the current status of non-GIS methods used in the Central Publications Group to produce 3-D terrain illustrations for use in USGS publications.

The poster presents a "cookbook" approach that includes all steps necessary to easily produce 3-D digital terrain illustrations. Toward that end, the poster reviews many of the steps discussed in Patterson (1998) and Sammis (1999). However, the poster presents additional information we think will be helpful to users, such as (1) how to maintain high resolution in 3-D terrain illustrations that will be used in print publications, (2) information on file formats and how to export 3-D images for further manipulation and corrections in Adobe PhotoShop and Illustrator, (3) information about tools in PhotoShop that are useful for manipulating colors and repairing imperfections in 3-D images exported from Bryce4, and (4) how to merge DEM's in Bryce4. Screen-optimized and print-optimized PDF's of the poster can be viewed and downloaded at URL <http://cpg.cr.usgs.gov/>. The authors thank Diane Wells and Gene Ellis for their helpful reviews.

REFERENCES

Patterson, Tom, 1998, 3D landscape presentation-experiments at the U.S. National Park Service: Paper presented at the German Society of Cartography-Working Group of High Mountain Cartography, Bielerhöhe, Austria, February 26-March 1, 1998; also available on the World Wide Web at URL <http://www.nps.gov/carto/silvretta/mtn.html> (on the server of the North American Cartographic Information Society).

Sammis, Ian, 1999, How to make relief maps with Bryce: MacADDICT, v. 4, no. 12, p. 94-96.

SOFTWARE FOR MAKING 3-D TERRAIN ILLUSTRATIONS

Bryce4: (a PC- and Mac-compatible computer program by MetaCreations); for more information see URL <http://www.metacreations.com>.

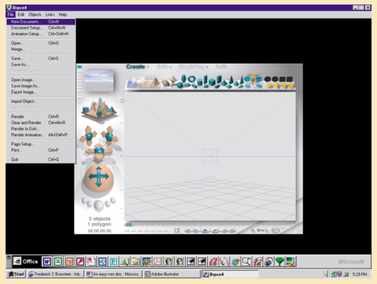
MICRODEM/TerraBase II 4.0: (a PC-compatible computer program written by Peter Guth of the Oceanography Department, U.S. Naval Academy); can be downloaded free of charge at URL <http://www.usna.edu/Users/oceano/pguth/website/microdem.htm> [Note: at the present time, this software has the ability to make, manipulate, and display 3-D terrain images, but no capability is provided in the software to export such images for use in other programs.]

MacDem Beta-0.7: [a Mac-compatible computer program written by Jerry Farm (<macdemweb@treeswallow.com>)]; can be downloaded free of charge at URL <http://www.nacis.org/cp/cp28/resources.html> [Note: at the present time, this software has the ability to make, manipulate, and display 3-D terrain images, but we are unsure of its capability to export such images for use in other programs.]

USGS WEB SITE FOR DOWNLOADING 1:24,000- AND 1:250,000-SCALE USGS DEM'S

[USGS DEM's are not available for other scales, such as 1:100,000, 1:500,000, and 1:1,000,000.]
<http://edcwww.cr.usgs.gov/doc/edchome/ndcdb/ndcdb.html>

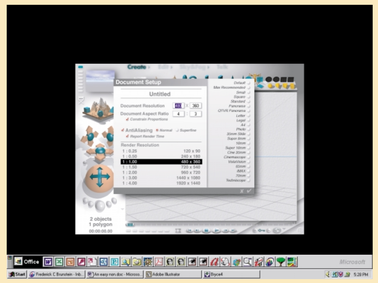
1



Obtain USGS DEM's from the USGS Web site. If necessary, decompress .gz files with WinZip or Stuffit. Decompress .tar files with tar software or Stuffit.

Open Bryce4.
Select *File>New Document.*

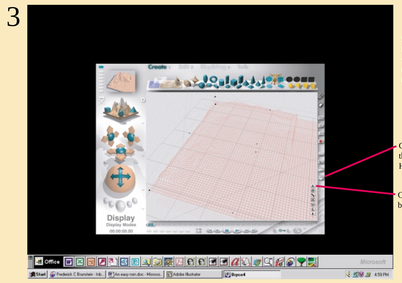
2



In the *Document Setup* window, select *Render Resolution* desired. Note that Bryce outputs 72 dpi files, which is fine for Web publications but is too low for print publications. However, resolution can be increased by increasing *Render Resolution* screen sizes, and then reducing and resampling the image at higher resolution in PhotoShop (see step 8). Larger screen sizes provide larger images composed of more pixels and provide sufficient resolution for print publications when reduced and resampled at higher resolution in PhotoShop (see step 8). The following table shows screen sizes converted to image sizes in inches and the sizes needed to convert to when resampling at 300 dpi in PhotoShop in order to theoretically preserve maximum detail (see step 8). However, it is often easier to use larger resample sizes than recommended below, and still produce acceptable results when resampling at 300+ dpi.

Render resolution (pixels)	**Size of image** (inches)	**Resample size at 300 dpi** (inches)
120 x 90	1.6 x 1.25	0.4 x 0.3
240 x180	3.3 x 2.5	0.8 x 0.6
480 x 360	6.6 x 5	1.6 x 1.2
720 x 540	10 x 7.5	2.3 x 1.8
960 x 720	13.3 x 10	3.2 x 2.3
1440 x 1080	20 x 15	4.8 x 3.6
1920 x 1440	26 x 20	6.2 x 4.8

3

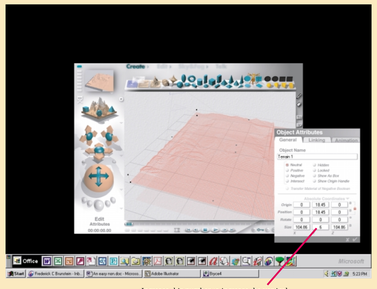


Select *File>Import Object*
Find your DEM file in the directory structure and click Open. Bryce will open the DEM and display wireframe image of the DEM.

Click on the wireframe icon to increase the density of wireframe, if desired. Higher numbers show more detail.

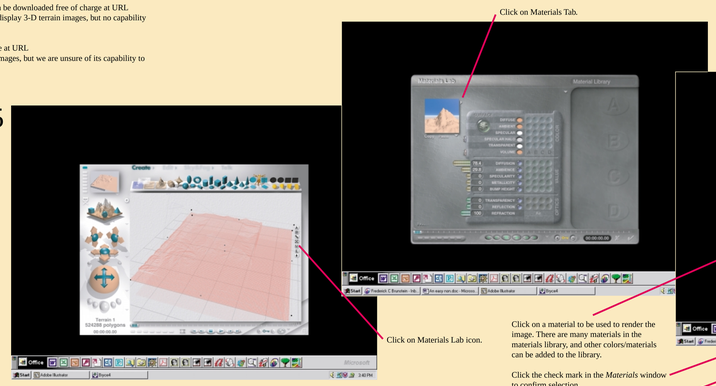
Click on the Attributes button. Dialog box will appear (next panel).

4



Increase this number to increase the vertical exaggeration so that topographic features show up better.

5



Click on Materials Tab.

Click on Materials Lab icon.

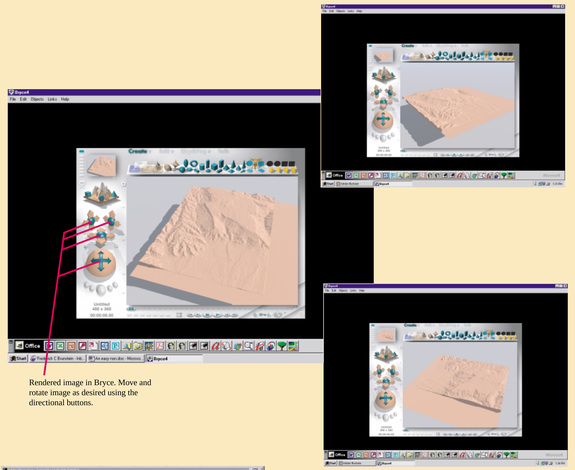
Click on a material to be used to render the image. There are many materials in the materials library, and other colors/materials can be added to the library.

Click the check mark in the *Materials* window to confirm selection.

Click the check mark in the *Materials Lab* window to confirm selection.

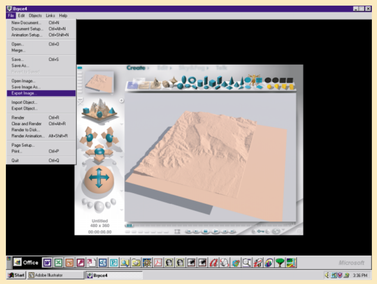
Click on the Render button to add material/color to your terrain. Bryce will render image in several passes and tell you when it is complete.

6



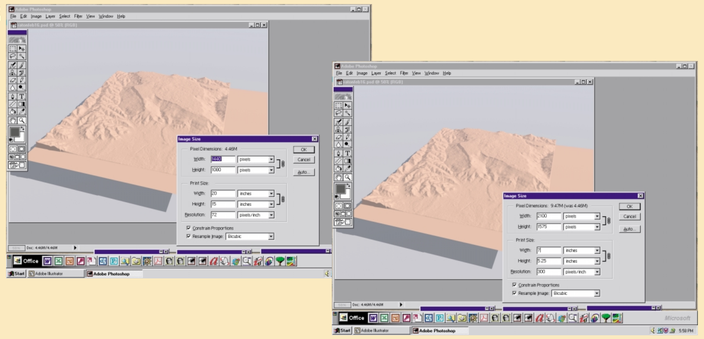
Rendered image in Bryce. Move and rotate image as desired using the directional buttons.

7



Select *File>Export Image*. Save the image in the desired file format. We would usually export the image as an Adobe PhotoShop file (.psd) for easy importing into PhotoShop for image cleanup, color changes, enlarging or reducing, resolution changes, and other modifications. The image can also be exported and/or saved as Bitmap (.bmp), GIF (.gif), HTML (.htm), JPEG (.jpg), MacPict (.pct), and TIFF (.tif) file formats. If you are not yet ready to export the image to PhotoShop, and still have further work to do in Bryce, the file can be saved as a Bryce4 file (.br4).

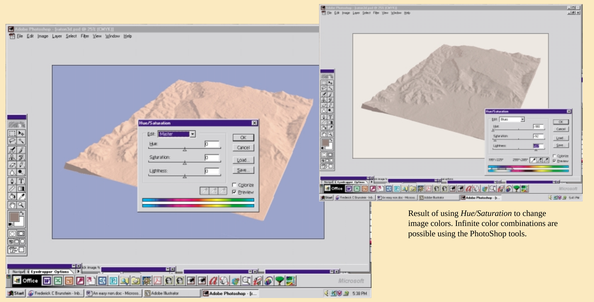
8



Open image in Adobe PhotoShop. Select *Image>Image Size*. Note that image comes out of Bryce having a resolution of 72 dpi, which is fine for viewing on a monitor but is too low for a publication that is printed on a printing press. However, the 72-dpi resolution figure is deceptive. If you used a large screen size (say 1440 by 1080 pixels) in Bryce, you will have plenty of pixels to provide adequate resolution in PhotoShop if you reduce the size of the image and resample the image at 300 dpi or higher. Reducing the image and resampling at higher resolution should be done in one step by plugging in the desired size and resolution in the *Image Size* dialogue box (shown at left). The following table shows the screen sizes in Bryce converted to image sizes in inches and the sizes needed to convert to when resampling at 300+ dpi in PhotoShop in order to theoretically preserve maximum detail. However, it is sometimes easier to use larger resample sizes than recommended, and still produce excellent results when resampling at 300+ dpi. You be the judge. Note in this example that increasing the resolution from 72 dpi to 300 dpi and decreasing the size from 20 by 15 inches to 7 by 5.25 inches has more than doubled the file size from 4.46 Mb to 9.47 Mb.

Resolution (Bryce) (pixels)	**Size of image** (inches)	**Resample size at 300 dpi** (inches)
120 x 90	1.6 x 1.25	0.4 x 0.3
240 x180	3.3 x 2.5	0.8 x 0.6
480 x 360	6.6 x 5	1.6 x 1.2
720 x 540	10 x 7.5	2.3 x 1.8
960 x 720	13.3 x 10	3.2 x 2.3
1440 x 1080	20 x 15	4.8 x 3.6
1920 x 1440	26 x 20	6.2 x 4.8

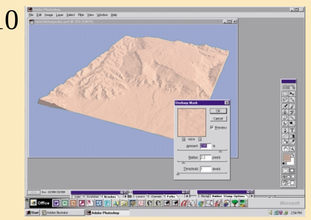
9



Result of using *Hue/Saturation* to change image colors. Infinite color combinations are possible using the PhotoShop tools.

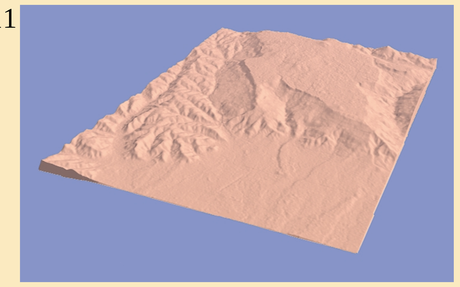
Note that the image has been cleaned up and colors changed. The "skirt" and parts of the shadow underneath the DEM have been removed and other clean up has been done. The *Magic Wand*, *Lasso*, *Eye Dropper*, *Paint Bucket*, *Pen*, and other tools were used to select and change the colors of the "skirt" and shadow to match the surrounding background color. Select *Image>Mode> Hue/Saturation* to adjust and change the color of image as desired. To change the background color without altering the terrain color, select the background color using the magic wand tool and then fill it with the desired color with the *Eye Dropper* and *Paint Bucket* tools.

10



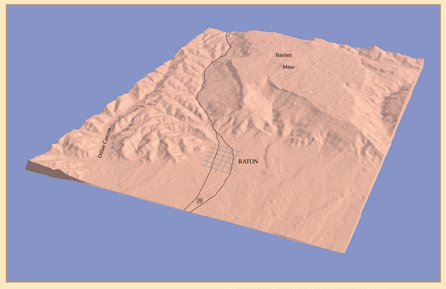
To make the image look sharper and crisper, select *Filter>Sharpen>Unsharp Mask*. In the *Unsharp Mask* dialogue box, use the sliders to adjust the values of *Amount*, *Radius*, and *Threshold*. The values shown in this example worked well to sharpen the image. You may want to experiment with other values to obtain the results you want. [Note: *Unsharp Mask* can sometimes create "jaggies" along the edge of the image. If desired, a clean, straight crop of the jaggies can be made using the *Pen Tool* to draw a closed rectangle that includes part of the blue area and the straight edge of the terrain. Then select *Window> Show Paths>Fill Subpath* (click *Foreground Color*, which is blue in this example). The rectangle will be filled with blue and the jaggies will be cropped. Then delete the path. Alternatively, other PhotoShop tools can be used to clean up the jaggies, or use the pen tool in Illustrator to draw a line along the edge of the image to hide the jagged edge.]

11



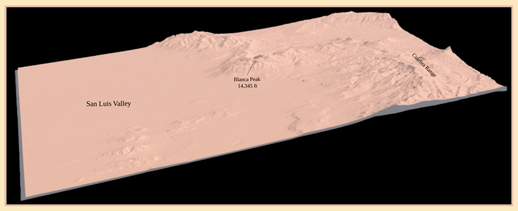
Final result from PhotoShop. The image is ready for further work in PhotoShop, or it can be imported into Adobe Illustrator to add desired type, linework, polygons, or symbols.

12

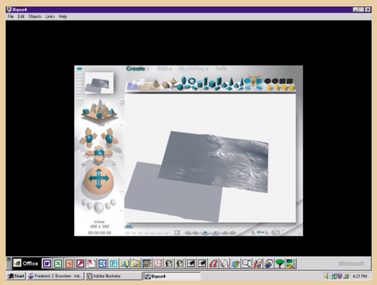


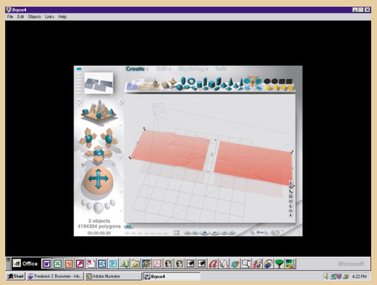
Here, the image has been imported into Adobe Illustrator to add lines, type, and a neatline.

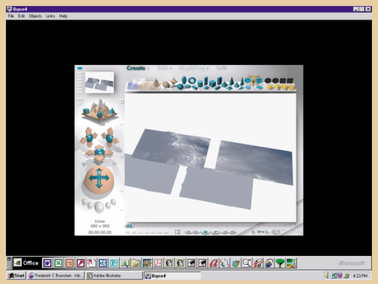
3-D image of the Raton, New Mexico-Colorado, 1:24,000-scale quadrangle.

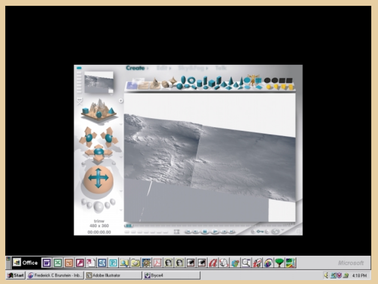


Two 3-D images of the west half of the Trinidad, Colorado, 1:250,000-scale quadrangle. The version on the left has had *Unsharp Mask* applied in order to sharpen the image. The version on the right did not have *Unsharp Mask* applied.









Merging DEM's

Example shown is the merging of the west and east halves of the Trinidad 1:250,000-scale quadrangle. First, in the *Document Setup* window, select the render resolution (see step 2 above). Then Select *File>Import Object* and navigate to the DEM of the west half of the quadrangle and open it. Then select *File>Import Object* and navigate to the DEM of the east half of the quadrangle and open it. Both DEM's are now in the same window. Use the cursor arrow and navigation arrows to select and move each of the DEM's for a best-fit merge. (It won't be perfect.) You will probably have to adjust the vertical exaggeration of one or both of the DEM's in order for the terrains to match up more closely. You'll also need to use the navigation arrows to look at all aspects of the merge because you are merging the DEM's in 3-D. Also note that certain colors work much better for merging DEM's. Some colors produce poor terrain matching. Dark brown is often a good color to use. (Pick dark brown in the *Simple and fast list*. Click on the Materials icon to see the *Simple and fast list*.) Select *File>Export Image* and export image as a .psd file. You can touch up the merge line and do other clean-up in PhotoShop, if desired.